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ABSTRACT

The purpose of this study was to develop and validate an instrument to assess students' culturally sensitive environments and to examine the associations between these factors and students' attitudes towards science. A measure of students' environment, namely, the Cultural Learning Environment Questionnaire (CLEQ), was developed. The instrument was influenced by Hofstede's four dimensions of culture (Power Distance, Uncertainty Avoidance, Individualism, and Masculinity/Femininity) and contained eight scales. Using a sample of over 3000 secondary science students, the reliability of the CLEQ scales ranged from 0.69 to 0.86 and showed acceptable discrimination between the scales. The mean correlation between scales ranged from 0.04 to 0.23. The reporting of the class or school mean is viewed as somewhat meaningless as this instrument was designed to measure students' personal cultural environment. An examination of the diversity of cultural environments in each classroom was indicated by examining the standard deviations of each scale for different classrooms. Relationships between students' cultural environments and attitudes was examined. Contains 22 references. (Author/PVD)

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Cultural Learning Environment in Science Classrooms: Validity and Application of a Questionnaire

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A paper presented at the Annual Meeting of the National Association for Research in Science Teaching,

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Abstract

The purpose of this study was to develop and validate an instrument to assess students' culturally sensitive environments, and to examine associations between these factors and students' attitudes towards science. A measure of students' environment, namely the Cultural Learning Environment Questionnaire (CLEQ), was developed. The instrument was influenced by Hofstede's four dimensions of culture (Power Distance, Uncertainty Avoidance, Individualism, and Masculinity/Femininity) and contained eight scales. Using a sample of over 3000 secondary science students, the reliability of the CLEQ scales ranged from 0.69 to 0.86 and showed acceptable discrimination between the scales. The mean correlation between scales ranged from 0.04 to 0.23. The authors' view reporting of the class or school mean as somewhat meaningless as this instrument was designed to measure students' personal cultural environment. An examination of the diversity of cultural environments in each classroom was indicated by examining the standard deviations of each scale for different classrooms. Relationships between students' cultural environment and attitudes was examined.

Many researchers have examined particular groups of students in regard to their world views (Anderson, 1988), styles of learning (Oakes, 1990), attitudes (Wiggins, Atwater and Gardner, 1992) and belief systems (Harvey, 1970). Much of this research suggests that students who come from different areas, display a distinct culture. That is, differences in attitudes, styles of learning, etc., can be explained more comprehensively if the local culture is considered. Culture is learned, people are not born with a culture (Stull & Von Till, 1994). Many students come from communities with widely differing cultural practices and at times the teaching and learning strategies adopted in science classrooms can be perceived as being in conflict with the natural learning strategies of the learner. Since teachers can use practices that may inadvertently conflict with students' previous learning patterns, home environment, mores and values, there is an increasing need for teachers to be sensitive to the important cultural milieu into which their teaching is placed (Thaman, 1993).

Teachers tend to find it difficult to understand the 'nature, causes and consequences of cultural conflicts in minority populations' (Delgado-Gaiten & Trueba, 1991, p. 24). As schools are becoming increasingly diverse in their scope and clientele, any examination of the interaction of culturally sensitive factors of students' learning environments with learning processes, assumes critical importance. While there are a number of research studies in science in existence concerning culture and education generally (Atwater, 1993, 1996; Cobern, in press; Maddock, 1981), comparatively little research examines the interaction that occurs between students' culturally sensitive learning environment and their learning. It is timely and relevant to examine how this aspect of students' learning environments enhances or inhibits their learning within a secondary school science classroom.

In this exploratory study, culture is defined as "the distinctive way of life of a group of people, their complete design for living" (Kluckhohn, 1951, p. 86). Therefore, it is feasible that at the macro-classroom level, there are distinctions that can be made between the ways of learning of different students. This paper describes the development of a questionnaire to assess culturally sensitive factors of learning environments and its application in investigating relationships between these classroom learning environment factors and students' attitude towards science and achievement on enquiry skills.

Assessing the Culturally Sensitive Learning Environment

In his research on human environments, Moos (1979) found that three general categories can be used in characterising diverse learning environments. This finding emerged from Moos' work in a variety of environments including hospital wards, school classrooms, prisons, military companies, university residences and work milieus. The three dimensions are: *relationship dimensions* which identify the nature and intensity of personal relationships within the environment and assess the extent to which

people are involved in the environment and support and help each other; *personal development* dimensions which assess personal growth and self-enhancement; and *system maintenance and system change* dimensions which involve the extent to which the environment is orderly, clear in expectations, maintains control, and is responsive to change.

In the past 25 years, Moos' work has influenced the development and use of instruments to assess the qualities of the classroom learning environment from the perspective of the student (Fraser, 1986, 1994; Fraser & Walberg, 1991). Examples of classroom environment instruments include: the *Learning Environment Inventory (LEI)* (Fraser, Anderson & Walberg, 1982) which measures student perceptions of 15 environment dimensions of secondary school classrooms; the *Classroom Environment Scale (CES)* (Moos & Trickett, 1987) which contains nine scales for use in secondary school classrooms; the *My Class Inventory (MCI)* (Fraser, Anderson & Walberg, 1982) which is suitable for use with children in the 8 to 12 years age range; and the *College and University Classroom Environment Inventory (CUCEI)* (Fraser, Treagust & Dennis, 1986) which is suitable for use in tertiary education settings. Other more specialised instruments include: the *Individualised Classroom Environment Questionnaire (ICEQ)* (Fraser, 1990) which assesses those dimensions which distinguish individualised classrooms from conventional ones; the *Science Laboratory Environment Inventory (SLEI)* (McRobbie & Fraser, 1993) suitable for assessing the environment of science laboratory classes at the senior secondary or tertiary levels; and the *Constructivist Learning Environment Survey (CLES)* (Taylor, Dawson & Fraser, 1995) designed to assist researchers and teachers assess the degree to which a particular classroom's environment is consistent with a constructivist epistemology. As the scales of all of these instruments can be categorised into one of the dimensions of Moos' scheme for classifying human environments referred to above, there is some commonality in the conceptual frameworks underpinning the assessment of classroom environment. It was thus determined that any instrument used in this study would also be based on Moos' dimensions.

However, none of the instruments referred to above was designed specifically to assess culturally sensitive factors of the student's learning environment and it was necessary to devise a new instrument. The new instrument utilised in this study was based on previous learning environment scales that a review of research literature indicated could be culturally important. The selection of these scales was guided further by an examination of literature from the fields of anthropology, sociology and management theory. In particular, the work of Hofstede (1984) and his dimensions of culture proved useful. After collecting information with a detailed questionnaire from thousands of individuals working in multi-national corporations operating in 40 countries, Hofstede (1984) analysed the data and identified four dimensions of culture, namely, *Power Distance, Uncertainty Avoidance, Individualism, and Masculinity/Femininity*. Other studies, for example, Bochner & Hesketh (1994)

and Stull & Von Till (1994) have used an instrument approach based on Hofstede's dimensions to study culture in education settings. Similarly, this study utilised an instrument containing scales whose construction was influenced by these four dimensions.

Table 1
Descriptive Information for Each Scale in the CLEQ Instrument

Scales	Description	Sample Item	Moos Dimension	Hofstede Cultural Dimension
Gender Equity	Measures the extent to which male and female students are treated equally.	I feel that comments in class by male and female students are equally important. (+)	Relationship	Masculinity/ Femininity
Collaboration	Measures the extent to which students are part of a strong cohesive group.	I feel that it is important for the class to work together as a team. (+)	Relationship	Individualism
Risk Involvement	Measures the extent to which students feel they can give their own opinion in class discussions.	I try to say what I think the teacher wants rather than give my own opinions. (-)	Relationship	Uncertainity Avoidance
Competition	Measures the extent to which the students are competitive with each other.	I like to compete against the other students. (+)	Personal Development	Individualism
Teacher Authority	Measures the extent to which students feel they can challenge or disagree with their teacher.	It is OK for me to disagree with the teacher. (-)	Personal Development	Power Distance
Modelling	Measures the extent to which the students prefer to learn by a process of modelling.	I like teachers to show me what to do. (+)	Personal Development	Uncertainity Avoidance
Congruence	Measures the extent to which the students feel learning at school matches their learning at home.	What I learn in this class helps me at home. (+)	System Change & Maintenance	Uncertainity Avoidance
Communication	Measures the extent to which students have more direct forms of communication with the person with whom they are interacting.	I like to be able to see as well as hear what is happening in class. (+)	System Change & Maintenance	Power Distance

Thus an instrument, provisionally identified as the *Cultural Learning Environment Questionnaire (CLEQ)*, was developed specifically for use in this study. The initial development of the CLEQ was guided by the following criteria:

i. Consistency with previous learning environment research. All relevant scales contained in relevant existing instruments for learning were examined for guidance in identifying the scales.
ii. Consistency with the social psychology, organisation sociology and anthropological literature.
iii. Consistency with the important cultural dimensions in the unique environment of multicultural organisations identified by Hofstede (1984).

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iv. Coverage of Moos' general dimensions. Scales for the CLEQ were chosen to include at least one scale from each of Moos' three dimensions.

v. Salience to teachers and students. By interviewing teachers and students an attempt was made to ensure that the CLEQ's scales and individual items were considered salient by teachers and students.

vi. Economy. The CLEQ was designed to have a relatively small number of reliable scales, each containing a small number of items.

The result was a questionnaire containing eight scales: Gender Equity, Collaboration, Risk Involvement, Competition, Teacher Authority, Modelling, Congruence, and Communication. A description of each of these scales, together with a sample item from each is provided in Table 1.

Methodology

The study reported here, is concerned with the culturally sensitive factors of the learning environments of secondary school students. The underlying premise of this research is that if we can identify the culturally sensitive factors of the learning environments of multicultural classes, then it follows that we have an opportunity to optimise the teaching strategies to be utilised with them. Specifically, the research seeks to determine the students' culturally sensitive learning environments and examine any associations with students' attitudes and enquiry skills. Therefore, the three research tasks were: to develop the CLEQ and determine its reliability and validity; investigate associations between students' culturally sensitive learning environments and their attitudes and enquiry skills; and to examine the variance of perceptions between selected schools.

Students' attitudes towards science were examined using selected items which were based on the *Test of Science -Related Attitudes* (Fraser, 1981). In this study, the Cronbach alpha reliability of this attitude scale was 0.79. Students' enquiry skills were examined using selected items from the *Test of Enquiry Skills* (Fraser, 1979). Again in the study, the reliability of this measure of enquiry skills was 0.69.

Table 2.

Factor Loadings for Items in 40-Item Version of Personal Form for the Individual Student as the Unit of Analysis

Item No	Gender Equity	Collabora-tion	Teacher Authority	Competition	Risk Involv.	Modelling	Congru-ence	Commun-ication
1.	.74							
2.	.74							
3.	.70							
4.	.71							
5.	.45							
6.		.81						
7.		.68						
8.		.62						
9.		.41						
10.		.81						
11.			.76					
12.		.34	.51					
13.			.77					
14.			.49					
15.			.41	.51				
16.				.78				
17.				.81				
18.				.69				
19.				.77				
20.				.79				
21.					.78			
22.					.81			
23.					.69			
24.					.77			
25.					.78			
26.						.64		
27.						.71		
28.						.67		
29.						.59		
30.						.62		
31.							.68	
32.							.77	
33.							.77	
34.							.72	
35.							.75	
36.								.74
37.								.74
38.								.78
39.								.67
40.								.54
% Variance	17.6	7.0	3.1	11.2	4.0	3.2	6.6	5.1
Eigenvalue	7.0	2.8	1.2	4.5	1.6	1.3	2.7	2.0

Factor Loadings smaller than 0.3 have been omitted.

The study involved a survey of 3,031 science students in 135 classes in 45 Australian secondary schools. The CLEQ contained 40 items which had been construct and content validated by teachers, students and fellow researchers. Each scale contained five items which were responded to on a five-point

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scale with the extreme alternatives of Disagree - Agree. Students were asked to indicate to what extent they agreed that each item described their science classroom.

Results

Factor Analyses

The first stage in the refinement and validation of the CLEQ involved a series of factor analyses the purpose of which was to examine the internal structure of the set of 40 items. Using SPSS, principal components analysis with varimax rotation was used to generate orthogonal factors. Since the instrument was designed with eight scales, a eight-factor solution was considered.

Table 2 shows the factor loadings obtained for 3,031 school students in 135 classes in 58 schools. The results in Table 2 were obtained using the individual student as the unit of analysis. The percentage variance extracted and eigenvalue associated with each factor also are recorded at the bottom of each scale. The only factor loadings included in this table are those greater than or equal to the conventionally accepted value of 0.30. Factor analyses supported the 40-item 8-scale version of CLEQ.

Instrument Reliability

The first research question explored involved the reliability and validity of the CLEQ instrument. The CLEQ data were subjected to item analysis and the internal consistency/reliability (Cronbach alpha reliability coefficient) and discriminant validity (mean correlation with other scales) are shown in Table 3. The table shows that for the sample of students the alpha coefficients ranged from 0.69 to 0.86 suggesting that each CLEQ scale has acceptable reliability, especially for scales containing a relatively small number of items. The mean correlation of a scale with other scales was used as a convenient measure of the discriminant validity of the CLEQ. The mean correlations ranged from 0.04 to 0.23 indicating that the CLEQ measures distinct, although somewhat overlapping, aspects of the learning environment. The conceptual distinctions among the scales are justified by both the factor analysis and the discriminant validity.

Table 3.
Mean, Item Mean, Cronbach Alpha Reliability and Discriminant Validity (Mean Correlation with other Scales) for each scale of the CLEQ.

Scale	No of Items	Alpha Reliability	Mean Correlation with Other Scales	Scale Item Mean
Gender Equity	5	0.74	0.11	3.56
Collaboration	5	0.74	0.15	3.08
Risk Involvement	5	0.69	0.18	1.97
Competition	5	0.86	0.20	2.03
Teacher Authority	5	0.78	0.04	2.05
Modelling	5	0.72	0.21	2.08
Congruence	5	0.83	0.22	2.41
Communication	5	0.80	0.23	2.65

The means of Gender Equity and Collaboration suggest that the students believed that the males and females were treated equally in their classes that there was a high degree of collaborative learning occurring. The lower mean for Risk Involvement suggests that students were reluctant to give their own opinions in class.

Outcomes

Past environment research has often investigated associations between student outcomes and the nature of the classroom environment (Fraser, 1994). In order to permit examination of the predictive validity (i.e., the ability to predict student outcomes) of the CLEQ, students completed a simple Likert-type questionnaire which assessed students' attitudes towards science (Fraser, 1981) and items on enquiry skills (Fraser, 1979). Simple correlational analyses were used in examining the degree of association between each of the CLEQ scales and attitude to science and between the CLEQ scales and achievement of enquiry skills. Overall, as depicted in Table 4, most of the scales of the CLEQ were found to be associated with students' attitudes and achievement of enquiry skills. Furthermore, it can be seen that all of the significant correlations were positive except for two cases in which greater levels of perceived Risk Involvement were associated with lower scores on attitude towards science and greater levels of Teacher Authority were associated with lower scores on enquiry skills. The highest correlations occurred with attitudes to science when students perceived greater levels of Congruence, Communication and Gender Equity in their classrooms. These three scales were also important for the achievement of enquiry skills.

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Table 4.
Student Outcomes - Simple and Multiple Correlation between Attitudes, Enquiry Skills and CLEQ Scales

CLEQ Scale	Simple Correlation(r)		Standardised Regression Weight (β)	
	Attitudes	Enquiry Skills	Attitudes	Enquiry Skills
Gender Equity	0.25 *	0.22 *	0.14 *	0.21 *
Collaboration	0.08 *	0.06 *	-0.01	-0.01
Teacher Authority	0.05 **	-0.06 *	-0.01	-0.11 *
Competition	0.17 *	0.11 *	0.12 *	0.11 *
Risk Involvement	-0.08 *	0.06 *	-0.09 *	0.07 *
Modelling	-0.04	-0.03	-0.14 *	-0.04 **
Congruence	0.32 *	0.12 *	0.24 *	0.06 *
Communication	0.31 *	0.13 *	0.20 *	0.04 *
Multiple Correlation, R			0.62 *	0.31 *
Sample Size	3,031	3,031	3,031	3,031

* $p<0.01$ ** $p<0.05$

These associations were further investigated using multiple regression. The magnitude and statistical significance of the regression coefficient provides a measure of the association between the outcomes and input variable when scores on the other input variables are held constant. The multiple regression analysis helps reduce the Type I error associated with simple correlational analysis. Beta weights and significance levels are reported in Table 4 for each CLEQ scale and it is noteworthy that there is a high degree of congruence with the results of the simple correlations. Table 4 shows that the number of significant regression weights for the multiple correlation analysis was six for attitudes and seven for enquiry skills. An examination of the signs of the significant beta weights in Table 4, reveals that the regression weight is positive for Gender Equity, Collaboration, Competition, Congruence and Communication for attitudes and enquiry skills, Teacher Authority for attitudes and Risk Involvement for enquiry skills, and was negative for Risk Involvement and Modelling with student attitude and Teacher Authority and Modelling with enquiry skills.

A visual examination of the school means suggested that there was little variation between schools for Gender Equity and Collaboration and most variation between schools for Competition and Congruence. To gain an appreciation of the variation within schools, the standard deviation of students' perceptions was examined. It was noted that a larger variance existed than suggested by just examining the means. The largest variation within a school appeared in Communication, Gender Equity and Congruence and the least maximum variation within a school occurred in Modelling and Competition. This range of

variance could suggest that some schools are fairly homogeneous while others have a large variation in their student population.

To examine this question further, four secondary schools were chosen for further examination. These schools could be described as an independent religious fundamentalist (Religious), a government, a long established independent (Independent), and a mining town school. Figure 1 depicts the scale means for students in these schools. Students in the Religious school perceived the greatest Competition, Congruence and Communication and the least Gender Equity and students in the Government school perceived the lowest Teacher Authority, Competition, Risk Involvement and Modelling. The Mining school reported the highest levels of Gender Equity and Collaboration. This high levels could be a result of the intercultural mix located in this mining town and the transient nature of its population. This intercultural mix could result in students being more exposed to different cultural perspectives and hence being more tolerant. The transiency could result in students not being able to form cliques and could require students to be more collaborative.

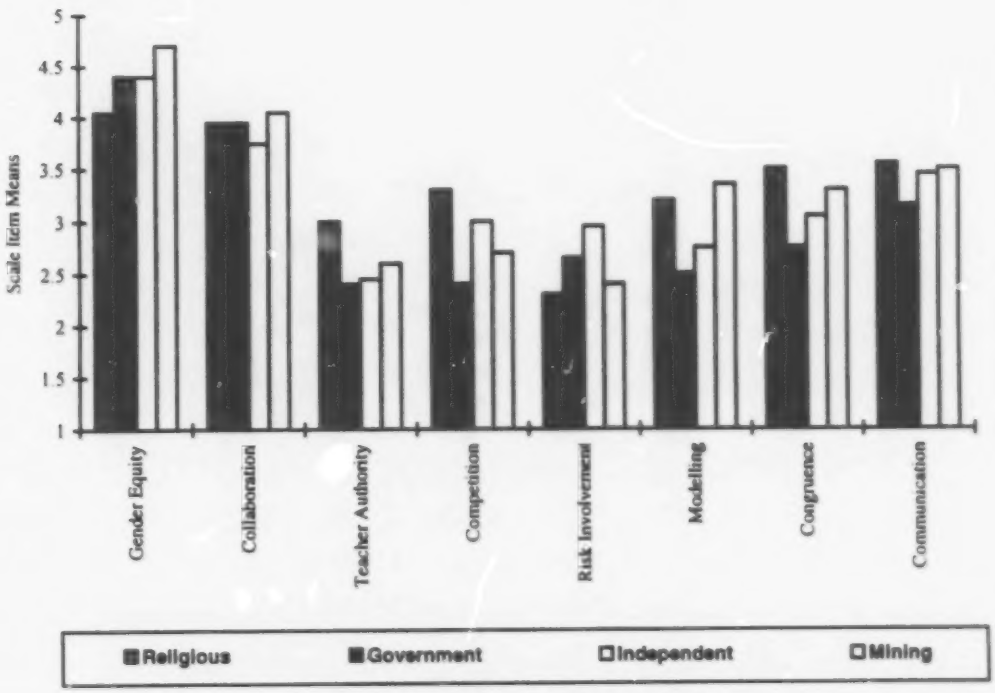

Figure 1. Scale Means for Each School

However, when the variance existing at each school (Figure 2) in the form of standard deviations was examined, the Mining school perceived the least variance in Gender Equity. The Government School while not having a high mean for Competition, displayed the most variance for Competition and Risk Involvement. Private school students while not being highly competitive against others had the its

greatest variance for Competition, Risk Involvement and Congruence. Fundamentalist school had its greatest variance in Competition and Risk Involvement and the least in Gender Equity. The authors argue that examination of the variance within the classroom indicates a degree of homogeniety and implies that the demand for variation in teaching approaches by different students is lower than that which would occur in a more diverse classroom.

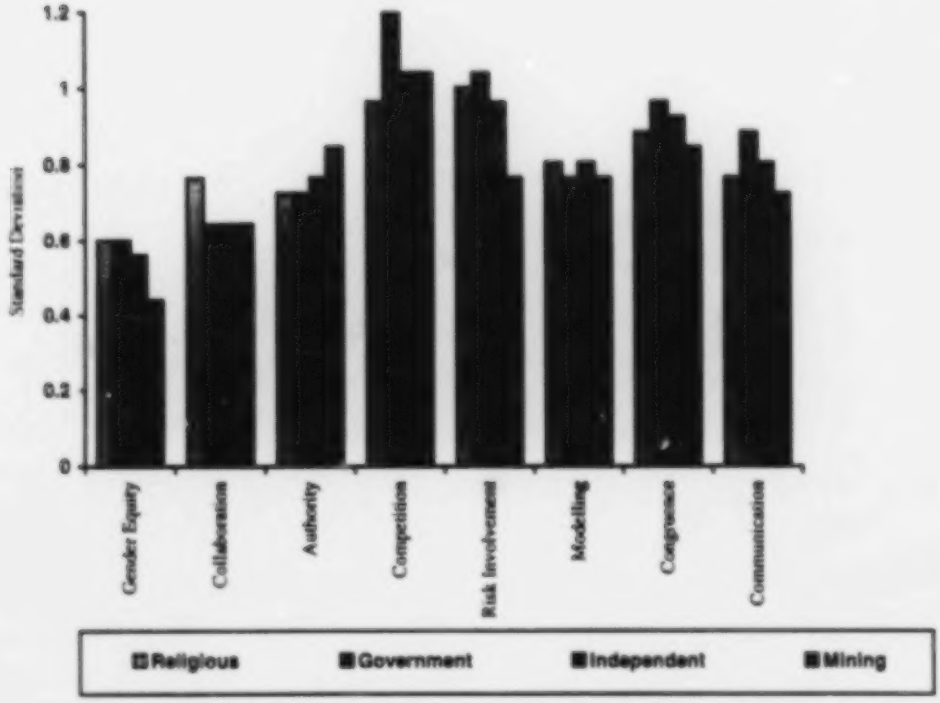

Figure 2. Range of Scale Standard Deviations for each School

Conclusion

This paper has described the development and validation of a questionnaire, (CLEQ) which assesses eight scales of the culturally sensitive learning environments of secondary school students. The paper provides initial validation information on the instrument and examines associations between students' perceptions of their culturally sensitive learning environment, their attitudes towards science and enquiry skills. The paper also examined differences in schools.

A measure of science students' cultural factors that might affect learning, namely the Cultural Learning Environment Questionnaire (CLEQ), was developed from past learning environment instruments and influenced by Hofstede's four dimensions of culture (Power Distance, Uncertainty Avoidance, Individualism and Masculinity/Femininity). The reliability and discriminant validity for each scale was obtained and and the reliabilty ranged between acceptable values of 0.69 and 0.86 for a new instrument. Associations between culturally sensitive factors of the students' learning environments and their attitudes and enquiry skills were found. Regression analysis suggested that more positive student attitudes are associated with more Gender Equity, Competition, Congruence, Communication and less Risk Involvement and Modelling. The development of student enquiry skills is associated with more Gender Equity, Competition, Risk Invovlement, Congruence, Communication and less Modelling. It is apparent that highly structured lessons which encourage students to model exactly what they have been shown are associated with lower students' attitudes towards science and achievement of enquiry skills. Examination of each school variance in the form of standard deviation showed the classrooms as being heterogeneous and a different range for each scale. It is possible that the more diverse classrooms suggest the need for teaching approaches to be varied and individualised to meet individual students' needs.

The underlying premise of this research is that if we can identify the culturally sensitive factor of the learning environments of our secondary students in a given science classroom then it follows that we have an opportunity to optimise the teaching strategies to be aligned with these factors. Teachers need to consider how different learning conditions are utilised given students' different perceptions of these culturally sensitive factors of their learning environments.

Perhaps teachers can utilize this new information to better match the teaching strategies they select for that class with the cultural expectations of their students. In practice, this would mean that the teacher, acting in the role of a school-based manager of learning, can select a balanced set of strategies and instructional approaches that are appropriate to the profile described by students.

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